Applications of Cloud Computing: a Survey

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Abstract

Cloud computing is a new paradigm in which computing resources such as processing, memory, and storage are not physically present at the user's location. Instead, a service provider owns and manages these resources, and users access them via the Internet. This paper brings brief details about the cloud computing with an outline of key features to give a foretaste about the new focused technology with its applications in different fields and also the scope of job opportunity in the field of cloud computing.

1. Introduction

Cloud computing refers to the many different types of services and applications being delivered in the internet cloud, and the fact that, in many cases, the devices used to access these services and applications do not require any special applications [1]. Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet) [2]. Cloud computing allows for the sharing and scalable deployment of services, as needed, from almost any location, and for which the customer can be billed based on actual usage [1]. Google states that cloud computing is to open standards and service-based, internet centric, safe, fast and convenient data storage and network computing service. IBM believes that cloud computing is a virtual pool of computing resources or a new mode of IT resources [3]. With cloud computing, most of the firms will shortly no longer have to maintain IT resources such as servers, storage and software in-house. They will be able to rent these as and when required, sharply reducing pricey upfront investments in IT infrastructure. While coders use frameworks such as .net and programming languages such as Java to create applications for traditional IT, writing cloud applications will require newer frameworks such as Spring Source and Ruby on Rails [4].

Many companies are delivering services from the cloud. Some notable examples are Google, Microsoft, and Salesforce.com etc. to name a few [1].

   i. Google — has a private cloud that it uses for delivering many different services to its users, including email access, document applications, text translations, maps, web analytics, and much more.

   ii. Microsoft — has Microsoft® SharePoint® online service that allows for content and business intelligence tools to be moved into the cloud, and Microsoft currently makes its office applications available in a cloud.

   iii. Salesforce.com — runs its application set for its customers in a cloud, and its Force.com and Vmforce.com products provide developers with platforms to build customized cloud services.

Cloud computing has a variety of characteristics, as discussed below [1]:

   i. Shared Infrastructure — uses a virtualized software model, enabling the sharing of physical services, storage, and networking capabilities.

   ii. Dynamic Provisioning — Allows for the provision of services based on current demand requirements. This dynamic scaling needs to be done while maintaining high levels of reliability and security.

   iii. Network Access — Needs to be accessed across the internet from a broad range of devices such as PCs, laptops, and mobile devices, using standards-based APIs (for example, ones based on HTTP). Deployments of services in the cloud include everything from using business applications to the latest application on the newest smartphones.

   iv. Managed Metering — uses metering for managing and optimizing the service and to provide reporting and billing information. In this way, consumers are billed for services according to how much they have actually used during the billing period.

Cloud computing services are deployed in terms of business models can differ depending on requirements. The primary service models being deployed are Infrastructure as a service (IaaS), Platform as a service (PaaS), Software as a service (SaaS) and Network as a service (NaaS) [2].

Deploying cloud computing can differ depending on requirements, and the following four deployment models namely Private Cloud (maintained and operated for a specific organization), Community Cloud (is shared among a number of organizations with similar interests and requirements), Public Cloud (the cloud infrastructure is available to the public on a commercial basis by a cloud service provider) and Hybrid Cloud (combination of private and public clouds) [1].

The following are some of the possible benefits of cloud computing-based services [1]:
  i. Cost Savings — Companies can reduce their capital expenditures and use operational expenditures for increasing their computing capabilities. This is a lower barrier to entry and also requires fewer in-house IT resources to provide system support.
  ii. Scalability/Flexibility — Companies can start with a small deployment and grow to a large deployment fairly rapidly, and then scale back if necessary. Also, the flexibility of cloud computing allows companies to use extra resources at peak times, enabling them to satisfy consumer demands.
  iii. Reliability — Services using multiple redundant sites can support business continuity and disaster recovery.
  iv. Maintenance — Cloud service providers do the system maintenance, and access is through APIs that do not require application installations onto PCs, thus further reducing maintenance requirements.
  v. Mobile Accessible — Mobile workers have increased productivity due to systems accessible in an infrastructure available from anywhere.

Three major challenges associated with Cloud computing are Security and Privacy, Lack of Standards and Continuously Evolving [1].
  i. Security and Privacy —relate to storing and securing data, and monitoring the use of the cloud by the service providers.
  ii. Lack of Standards — Clouds have documented interfaces; however, no standards are associated with these, and thus it is unlikely that most clouds will be interoperable.
  iii. Continuously Evolving — User requirements are continuously evolving, as are the requirements for interfaces, networking, and storage. This means that a "cloud,"

especially a public one, does not remain static and is also continuously evolving.

In this paper, survey on jobs and market of cloud computing is discussed in Section 2, followed by applications of cloud computing in the various fields in Section 3. Finally the concluding remarks are mentioned in Section 4.

2. Survey on Jobs and Market of Cloud Computing

A recent study commissioned by Microsoft and conducted by International Data Corporation (IDC), USA, has reported that cloud computing will generate some 14 million jobs worldwide by 2015, and India alone it will create over 2 million [6, 7]. The Microsoft IDC study estimates that the revenues from cloud innovation could reach as high as $1.1 trillion a year by 2015 from $400 billion in 2011, where some $28 billion was spent worldwide on public cloud it services 1.5 million jobs. The study predicts over two million jobs each to be generated in the communications and media and manufacturing sectors, followed by banking over 1.4 million. Though there is no such break-up available for Indian market, the footprint is expected to be more or less similar to global markets [6,7]. While the enterprises are exploring the possibilities of adopting this technology, it is essential for these enterprises to critically evaluate the likelihood of this technology for their specific businesses.

In 2012, more than 1.7 million jobs related to cloud computing were remained unfilled worldwide. The reason for this is lack of training and certification. Research firm, International Data Corporation (IDC) titled in a new report "Climate Change: Cloud's Impact on IT Organizations and Staffing" sponsored by Microsoft reported that the demand for cloud-savvy IT professionals will grow by 26% annually until 2015 and will create more than seven million cloud-related vacancies worldwide. The report identified cloud related skill areas such as senior management, project and program managers, business analysts, application development and maintenance, IT systems and operations, network, telecom, security, and web management, help desk and end-user support will be key to building and maintaining cloud infrastructure within organizations [5].

A study by EMC and Zinnov Management Consulting estimates the total cloud market in India at $400 million: this is expected to touch $4.5 billion by 2015. It expects the private cloud market, where the infrastructure is operated for specific companies, to create 100,000 IT jobs by 2015 from 10,000 today (Figure 1) [4]. In addition to technical jobs, marketing and selling of cloud-based solutions will also be essential, which in turn will create a host of new

positions. According to a paper by research IDC, jobs will be created across functional areas such as marketing, sales, finance and administration, production and service. More than 50 per cent will be in small and medium businesses, two million plus each in communications and media, and manufacturing, and over 1.4 million in banking. Of the 13.8 million jobs created globally by 2015 because of cloud computing, two million will be in India (Figure 2) [4].
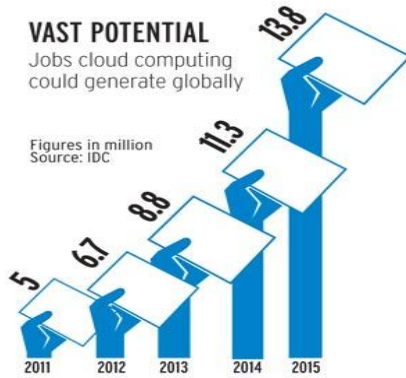

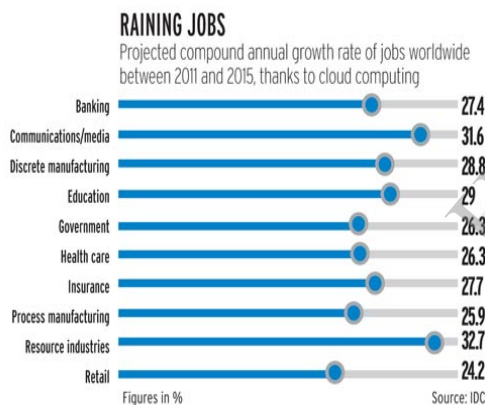**Figure 1. Jobs cloud computing creating globally [4]**

Figure 2. Rate of jobs in different business fields [4]

3. Applications of Cloud Computing in Different Fields

Cloud computing has been employed in various fields including banking, communications/media, education, government, healthcare, insurance, process manufacturing, resource industries and retail.

3.1. Banking

Cloud computing can help financial institutions improve performance in a number of ways [8].

3.1.1. Cost Savings and Usage-based Billing

With cloud computing, financial institutions can turn a large up-front capital expenditure into a smaller, ongoing operational cost. There is no need for heavy investments in new hardware and software. In addition, the unique nature of cloud computing allows financial institutions to pick and choose the services required on a pay-as-you-go basis.

3.1.2. Business Continuity

With cloud computing, the provider is responsible for managing the technology. Financial firms can gain a higher level of data protection, fault tolerance, and disaster recovery. Cloud computing also provides a high level of redundancy and back-up at lower price than traditional managed solutions.

3.1.3. Business Agility and Focus

The flexibility of cloud-based operating models lets financial institutions experience shorter development cycles for new products. This supports a faster and more efficient response to the needs of banking customers. Since the cloud is available on-demand, less infrastructure investments are required, saving initial set-up time. Cloud computing also allows new product development to move forward without capital investment. Cloud computing also allows businesses to move non-critical services to the cloud, including software patches, maintenance, and other computing issues. As a result, firms can focus more on the business of financial services, not IT.

3.1.4. Green IT

Organizations can use cloud computing to transfer their services to a virtual environment that reduces the energy consumption and carbon footprint that comes from setting up a physical infrastructure. It also leads to more efficient utilization of computing power and less idle time.

3.2. Communications/Media & Entertainment Industry

The troika of service-oriented architecture (SOA), digital supply chain, and cloud is evolving into the blueprint for enjoying innovation with the potential to reduce capital expense and operating expense. This triad of technologies, SOA, digital supply chain, and cloud will enable media companies to keep pace with turbulent times by providing [9]:

   i. Faster time to market
  ii. Increased sales by increasing exposure to content
 iii. A richer flow of information to adapt quickly to changing consumer interests and demand
 iv. Decreased labour, inventory, and working capital costs
  v. Faster, fresher content packaged, identified, and available to the right consumer anywhere, anytime.

Using cloud computing, media companies are developing new and better ways to quickly and efficiently deliver content to fine-grained targeted consumers. Cloud computing represents many opportunities for media companies to improve their competitive advantage by getting content to multichannel, three-screen (or even four-screen) markets faster than ever before while potentially reducing costs [9].

3.3. Education

At their January 22, 2009, meeting, members of the EDUCAUSE Board of Directors advised the staff that: (1) they believed that the time was right for EDUCAUSE to assume a more activist role in promoting higher education; and (2) the shift to above-campus computing prompted by the maturation of "cloud computing" and related emerging technologies deserved close EDUCAUSE attention and probable action. Since then, EDUCAUSE has engaged in [10]:

i. A thorough review of the literature on the topic
ii. A framing of the roles that EDUCAUSE might play in this emerging area of activity, and
iii. Interviews and focus group discussions to elicit the views of members and leaders in the community.

Benefits of Cloud for Education include [11]:

i. Reshaping teaching by extending interactive multimedia learning environments to anyone, anywhere
ii. Accelerating delivery of administrative services
iii. Simplifying operations, saving time, and cutting cost
iv. Reducing risk and strengthening security

3.4. Government

The Programme for Government and the Public Service Reform Plan highlight Information and Communications Technologies (ICT) as key enablers to delivering improved public services. Implementation of the ICT elements of the Programme and the Reform Plan will ensure a strong focus on the customer and that better and more innovative use is made of technology to improve the customer experience. A document entitled Cloud Computing Strategy sets out a strategic approach for the public service to engage with Cloud Computing and to undertake a comprehensive programme of Data Centre Consolidation. It positions both as key elements of the public service's ICT Strategy. It details the criteria to be considered by individual public bodies when considering public Cloud offerings, and highlights

how a Public Service Community Cloud will be progressively phased in [12].

Cloud Computing is a radically new approach to the delivery of ICT services which promises – [12]:

i. "anywhere" access to shared computing resources;
ii. "freedom" from capital expenditure on back-end computing equipment and software;
iii. The ability to provision computing services very quickly and cheaper than traditional models; and
iv. The ability to pay for such services on some form of metered or per-use basis.

3.5. Healthcare

In healthcare, cloud computing can support a wide range of organizational structures and business services, such as electronic health records, e-prescribing, practice management, computerized physician order entry (CPOE), billing and administration, etc. The healthcare industry has not rushed to the cloud as quickly as many other industries, but a fast-growing number of healthcare cloud-based services are available, and certainly interest is growing among healthcare providers [13].

In healthcare, the pace of change is increasing, along with the complexity of delivering higher quality care for significantly fewer dollars per patient. Hospitals and physicians are looking for strategies to increase business flexibility, while demonstrating greater healthcare value. To do so, a transformation from institution-centered, data-poor systems to patient-centered, information-rich health systems is needed. A flexible and scalable approach to applications and infrastructure can help healthcare organizations support new business approaches and seamless patient experiences [14].

Cloud computing in health care can be employed for [15]:

i. Faster Deployment of EHR technology
ii. Data Sharing/Enhanced Collaboration
iii. Management of "Big Data"
iv. Longitudinal Patient Medical Record
v. Revenue Cycle Management
vi. Claims Processing
vii. Enrollment

3.6. Insurance

The three major trends in cloud computing for insurance that can change the way insurers do business [17]:

i. Real-time data collection
ii. Making use of the full cloud stack
iii. Opportunities for increased customer engagement.

Experience to date shows that the key drivers of cloud computing in insurance include the ability to [16]:

i. Reduce total costs of IT ownership and operation
ii. Unify customer data, enabling customer-centricity
iii. Drive new business and engage customers more effectively through new distribution models
iv. Handle peaks in demand more easily and at lower cost
v. Reduce speed to market and drive new business opportunities
vi. Force a move to a service-oriented model and new innovation in systems design
vii. Better manage intermediary relationships
viii. Maximize renewals by customers
ix. Support integration of third party systems/agency management systems.

3.7. Process Manufacturing

The manufacturing industry has an "immediate appetite" for cloud computing. So say the researchers and analysts at IDC Manufacturing Insights. Their recent survey of manufacturing companies, titled "Business Strategy: Cloud Computing in Manufacturing" found that 22% of manufacturers had already incorporated cloud computing into their IT portfolios, and that 44% were in the process of doing so or had firm plans to do so. That means two-thirds of manufacturers are sold on the concept of cloud computing because of cost saving and a mere 2% have no plans for cloud adoption [18].

By a wide margin, manufacturers ranked reducing hardware costs as the top benefit of cloud adoption, according to IDC. They also expressed a desire to reduce software costs. And as they shift IT resources to this new model, they're more bullish on external, private clouds than public clouds, though the use of both is on the rise. IDC attributes the disparity to manufacturers' interest in protecting company data, and the perception that a private cloud is the more secure platform [18].

3.8. Resource Industries

Industrial problems are very complex and need lot of money and efforts. Availability of expertise and skills causes another problem in the industry. Enterprise resources management solutions are one of the example for this kind of problem. The complicated project of an ERP system implementation in industry results in large changes in the systems [19].

ERP software brings users economic benefits during a company's operational management. The economic benefits of ERP users are better than the non-users. All the data and information resources are managed by Enterprise Resource Planning Systems in the business organizations. This information is stored in centralized and shared data stores. Nowadays information is a priceless tool for organizations and through this perspective it is important to reach all the data of a company IT system in real time. The key is the mobility of the ERP system. We can use Cloud computing infrastructure & SaaS for low cost working. Here Cloud computing infrastructure is just a web service interface to operating system virtualization [19].

3.9. Retail

Retailers constantly strive to improve efficiency and reduce cost. Managing their large application portfolios has become increasingly complex and expensive and their IT departments frequently must support vertically-focused applications with overlapping functions. Simply put, cloud computing can reduce the IT costs of managing existing and new systems [20].

Cloud computing is a compelling answer to many retail challenges. For example, recent analysis indicates that, in some cases, private cloud implementations built around larger virtualized servers are almost 90 percent less expensive than a distributed, stand-alone server approach. Cloud computing also offers virtualized storage at significant savings and efficient service management and automated provisioning, which can lower the costs of adding IT resources than doing so with traditional mechanisms [20].

According to the Cisco® Internet Business Solutions Group (IBSG), cloud computing encompasses a combination of well-tested IT best practices that have high impact in terms of cost, speed, and agility. And while cloud is the subject of considerable publicity (and perhaps hype), it is already speeding time to market, accelerating innovation, lowering costs, and improving management for leading retailers. Cloud consists of the following best practices for the retail industry [21]:

i. Virtualization of data center and store computing resources to increase utilization.
ii. Network-based architectures that centralize IT resources, reduce costs, and serve mobile workers.
iii. Sourcing of computing services in pre-assembled stacks to speed delivery of new retail solutions.
iv. Flexible payment models to ease the burden of financing large capital expenditures.

4. Conclusion

This paper brought a glimpse of understanding on cloud computing as a technology for a new era and its applications in various fields namely banking, communications/media, education, government, healthcare, insurance, process manufacturing, resource industries and retail. This paper also brings out the job opportunity of cloud computing in various fields. Some of the benefits of cloud computing could be less initial capital investment, a smaller amount of time will be required to start new services, maintenance and operation costs could go lower, effective utilization through virtualization and the most important thing is simpler disaster recovery. All these points make cloud computing a striking option. Hence one can think of moving from desktop to cloud.

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